INVENTIONS & INNOVATION

Project Fact Sheet

Advanced Overfire Air System for Stoker Boilers and Furnaces

A new system for introducing overfire combustion air in stoker boilers and furnaces boosts efficiency and reduces harmful emissions

Benefits

- Could save 19.3 billion Btu of coal per installation annually
- Could save 3.1 trillion Btu annually by 2010
- Increases co-firing biomass with coal, further reducing NO_x, SO_2, and CO_2 emissions
- Eliminates hot spots in the boiler due to inadequate flue gas mixing

Applications

The advanced overfire air system is primarily applicable to commercial, institutional, and industrial manufacturing facilities that currently use solid fuel in furnaces and boilers to generate steam and electricity. A principal market for this technology is the forest products industry, where facilities generate wood waste and are heavy consumers of electricity and steam. Facilities that have serious energy inefficiency, combustion problems, or environmental emissions issues are expected to show the greatest initial interest in this technology.

The advanced overfire air system is designed to improve boiler efficiency while also reducing NO_x, SO_2, CO_2, and particulate emissions. According to a 1996 survey sponsored by the Gas Research Institute, approximately 3000 stoker boilers exist in 1600 commercial, institutional, and forest products facilities. The annual energy savings for a 5% boiler-efficiency improvement are estimated at $123 million based on a coal price of $1.50 per million Btu, or $27.50 per ton.

The first reported application of overfire air for combustion in solid-fuel boilers was in 1800. The technology continued to develop until the 1940s, when fan-driven overfire air was accepted nationwide as a method for reducing smoke emissions. During the intervening 60 years, development of this technology has been limited.

Stoker furnace designs produce nonuniformities that result in incomplete combustion and unburned carbon in the fly and bottom ash. In addition, current designs operate with high amounts of excess air, producing poorer boiler efficiencies than could be attained and more NO_x, SO_2, CO_2, and particulate emissions than necessary.

Overfire Air System for Stoker Boiler and Furnaces

The advanced overfire air system, developed by Eugene Berkau and shown installed at the Vanderbilt University power plant, improves boiler efficiency while reducing air emissions.

Project Description

Goal: Design, install, and optimize a prototype advanced overfire air system on two stoker boilers that can burn coal, biomass, and a mixture of these fuels.

The advanced overfire air system injects air at a controlled temperature, momentum, and direction that is specific to the combustion device, fuel, and load to efficiently mix unburned particles and volatile organics with the flue gases. The invention is designed to provide almost complete burnout of the fly and bottom ash carbon content at excess air levels of 3% to 5% at full load, providing improved combustion efficiencies.

The overfire air-injection configuration is intended to provide uniform mixing of the flue gases, particulates, and volatile hydrocarbons above the bed, something not achieved with conventional opposed-overfire air designs. This enhancement should improve efficiency and reduce emissions. The direction, momentum, temperature, and amount of overfire air injection can be tailored to the specific furnace or boiler design and solid fuel type to provide the desired temperature, excess air, and mixing for carbon burnout, efficiency improvement, and NO_x reduction.

Eugene E. Berkau developed this new technology with the help of a grant funded by the Inventions and Innovation Program in the U.S. Department of Energy's Office of Industrial Technologies.

Progress and Milestones

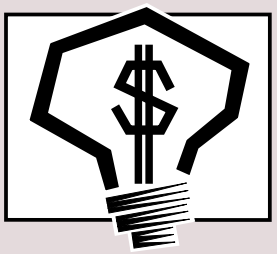
- Perform PCGC-3 model simulation for testing on two solid-fuel boilers.
- Construct and test advanced overfire air systems on two solid-fuel boilers.
- Evaluate data to optimize the advanced overfire air system.
- Standardize the methodology for evaluating and designing advanced overfire air systems.
- Conduct a conference for the owners and operators of stoker boilers and furnaces to address the economic and environmental benefits of the new overfire air systems.
- Identify new concepts and procedures for advanced overfire air systems.

Economics and Commercial Potential

An estimated 950 industrial facilities in the United States operate nearly 2000 stoker boilers. The estimated cost of an advanced overfire air system is about $250,000, for a total U.S. market value of approximately $500 million. The primary target market segments are the estimated 500 stokers at commercial and institutional facilities and the 1100 stokers in forest products facilities. An estimated 1% to 2% of these units will undergo a retrofit with the advanced tangential overfire air system within 2 years of market entry, representing sales of 16 to 32 units.

A recent study conducted by the technology's developers suggests that an efficiency improvement of 5% for the existing population of stoker boilers is reasonable and achievable. The annual energy-savings potential for a 5% boiler-efficiency improvement is more than 3 million tons of coal or approximately $123 million based on a coal price of $1.50 per million Btu. Emissions reductions should be proportional to the reduction in fuel use. Implementing this technology in all applicable locations could reduce SO_2 emissions by at least 200,000 tons and NO_x emissions by 170,000 tons.

This technology could save 19.3 billion Btu of energy per installation each year. First sales for this technology are expected by 2003. Based on 10% market penetration by 2010, annual savings could be 3.1 trillion Btu with 160 units installed. Market penetration of 30% by 2020 could save 10.7 trillion Btu from the operation of 555 units.



The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and conduct early development. Ideas that have significant energy savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

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